DRAINAGE REPORT

BELTA SUBDIVISION
128 BAYBERRY LANE
WESTPORT, CT

Prepared For:

Estate of Dina M. & James S. Belta
128 Bayberry Lane
Westport, CT 06880

PREPARED BY:

DYMAR

800 Main Street South
Southbury, CT 06488
Telephone: (203) 267-1046
Fax: (203) 267-1547
E-Mail: dymar@dymarinc.com

Dated: May 8, 2020
Revised: August 20, 2020
Job #00934

TABLE OF CONTENTS

SECTION 1.0

STORMWATER ANALYSIS

1.1 PREAMBLE

The intent of this report is to summarize the "Final" Stormwater Management Study for the proposed Belta Subdivision development, which is based on DYMAR's evaluation of the regulatory criteria, existing site conditions and the proposed development plan. Reference is made to Figure #1 for the proposed project's site location. It is the objective of the development team to present to the Town of Westport (Town) all of the pertinent site factors which have influenced the plan in an effort to solidify a final design proposal, which can find a balance between quality, technical adequacy, and environmental protection. Specific to this mission is the assessment of the stormwater management opportunities, constraints and the various competing site factors that are important to the design and layout of stormwater systems. The initial goal is to identify a technical approach, which has sufficient merit to minimize impacts based on an evaluation of management approaches for controlling the quantity and quality of water leaving the site. Elements, which were most critical in developing a Stormwater Plan, included the following:

A. An inventory and inspection of the site soils and surficial geology, wetland / watercourses, watershed surface drainage and runoff patterns, general forms of vegetation, topographic shapes, slopes and orientation, and relationships to adjoining properties;

B. The preparation of a viable site development plan;

C. Review of zoning and land use regulations;

D. Review of infrastructure capacity, demands, and standards;

E. Assessment of engineering and construction practices;

F. Identification of any potential off-site impacts; and

G. Identification of stormwater control and the Best Management Practices (BMP) to minimize impacts or improve existing conditions.

1.2 STUDY PURPOSE

The general purpose of this study is to 1) provide estimates for the storm water runoff for the existing conditions, 2) to analyze and provide quantitative estimates of how the development proposal affects the existing infrastructure and downstream properties utilizing accepted engineering methodologies and 3) to provide recommended stormwater practices which align itself with the current guidelines adopted by the Town and the Connecticut Department of Energy and Environmental Protection (CTDEEP) for water quality and water quantity planning, design and implementation. This includes the Town's Site Plan and Storm Water Drainage Design Standards issued 9/16/2014, the "2000 Connecticut Guidelines for Soil Erosion and Sediment Control", the "2004 Connecticut Stormwater Quality

Manual" and the "Connecticut Department of Transportation Drainage Manual". These CTDEEP and CTDOT publications were used for this project and are available to designers and regulators as reference guides in developing technically sound design solutions for source controls and pollution prevention in managing stormwater during construction and over the long term.

This study includes Hydrological and Hydraulic Analyses of the watershed as well as the analysis and design for the proposed on-site collection and conveyance system to demonstrate its suitability in satisfying local regulations. State guidelines for stormwater quantity and quality management were also used in sizing structural and non-structural measures prepared for the site.

1.3 EXISTING SITE CONDITIONS

The project site is located in Westport, CT within the AAA Residential Zone at 128 Bayberry Lane. The Belta family has commercially farmed the property since 1946. The total acreage of the parcel is 23 +/- acres comprised of Parcel A (21.5 ac.) and Parcel B (1.5 ac.) Currently two residential structures, three green houses and miscellaneous accessory farm uses are located on the property. The land is bounded to the north by the Muddy Brook and an associated wetland system, by other residential properties to the south and east, and by Bayberry Lane to the west. A series of subsurface deep test holes was conducted by DYMAR in February 2018, July 2019, February 2020 and May 2020. The testing consisted of 72 deep test holes and about 35 percolation tests. These include seven test pits conducted with the Town Department of Public Works/Engineering in February of 2020 for feasibility of roof storm water runoff recharge systems. The remainder of the testing was conducted for soil suitability for septic systems. The site subsurface conditions are a combination of naturally occurring soils and bedrock at varying elevations with topsoil fill deposited for farming purposes.

Stormwater runoff crosses the site from the southeast corner and runs to the northwest corner to the existing wetlands. The wetlands follow the northern and western property lines and eventually discharge to the Muddy Brook. A small portion of the brook crosses the property and is conveyed under Bayberry Lane by twin 24" culverts.

The site has access to a public water supply system and natural gas. Properties in the area are served by private septic systems. The property slopes radially from southeast to northwest at an average grade of 4.9 +/- %. The change in grade is from elevation 184.9' +/- near the center of the property to 158.2' at the northeast corner from the southeast corner to elevation 154' near the Muddy Brook. There are 3.45 +/- acres of wetlands on the site.

Refer to Figure #2 for existing conditions.

Refer to Table #1 for runoff characteristics.

1.4 PROPOSED DEVELOPMENT PLAN

The current proposal is to seek approval for an "Open Space Subdivision", creating 9 lots, two of which will serve the Belta Family. The infrastructure will consist of a private 960-

foot long road at 22 feet wide with a 50-foot radius cul-de-sac. The lots are to be served via underground utilities for water, gas and electrical/telephone/cable with private septic systems to service each lot. The storm sewer system consists of a network of catch basins with deep sumps and hooded outlets, and manholes to convey storm water from the pavement to the proposed detention basin. The natural radial topography of the site has been maintained under the proposed grading plan. There are no direct impacts to wetlands or watercourses. The upland review is impacted by an estimated 700 sft that is associated with the outlets for the underdrain needed below the bio swales.

The proposed storm water sewer design has been divided into two parts. The first part is to capture the roofs' runoff and convey the volume to an underground plastic chamber storage and exfiltration technology. The proposed systems will vary to match the requirements of capturing and storing the first 1" of storm water for each proposed lot. For design purposes, the systems are sized for pure storage with no credit taken for infiltration or detention.

The second part consists of the design, construction and maintenance of an at-grade detention basin to treat and detain the storm water runoff for approximately 6.7 +/- acres of the developed site, including 550 feet of the proposed road. The detention basin was sized with no detention on the lots, lot development based on the potential of 25% impervious coverage (raising the CN values) and no credit taken for pre-existing impervious cover, packed earth paths and cultivated crop fields (lower pre-development CN values). The remainder of the road runoff flows towards Bayberry Lane where it will be captured and conveyed to a water quality treatment manhole (CDS Treatment Unit), before entering the Bayberry Lane storm sewer infrastructure.

The proposed detention basin includes a forebay to provide storm water treatment for the private road and tributary areas associated with the lots. The forebay is sized to meet the CTDEEP requirements for the first flush or 1" of storm water volume of the runoff, which is considered by the CTDEEP to be the highest concentration of pollutants. The outlet control structure (OCS#1) consists of a multi stage hydraulic control system comprising of two 8" orifices, six 3 feet long x 6" high combination weir/orifice, and a double catch basin overflow spillway for the significant storm events. The crest of the basin is set at elevation 165.0 that is 8 feet wide with side slopes at 3H:1V. The freeboard provided at the 100-year storm (el. 164.0) is one foot. The 15" discharge pipe connects to an 18 inch "T" manifold diverter that distributes flow to a modified riprap energy dissipater, which then flows into a 190' long bio swale and concrete weir level spreader. The level spreader's overflow discharges to a small stone gravel dissipater strip, which is designed to shed the water to natural occurring soils and the riparian buffer at low velocities. By example, the discharge velocity is estimated at 0.772 feet per second and 0.985 feet per second for the 25 and 100-year storm, respectively. Reference is made to Table #5 for the Detention Basin Weir Rating Curve and predicted velocities for each storm event. It is noted that in Part 654 of the National Engineering Handbook Table 8-4 provides allowable velocities for various channel materials based on shear velocity to minimize erosion. In earth, sandy slit has a mean velocity limit of 2 feet per second and silty clay at 3.5 feet per second. This table can be found in Appendix 'C'.

Refer to Figure #3 for proposed post-development conditions.

Refer to Table #2 for post-development runoff characteristics.

Refer to Table #4 for pre- and post-development runoff comparisons.

Refer to Appendix 'B' for Water Quality Volume calculations.

1.5 METHODOLOGY

The study reviews the impact of the proposed stormwater management plan on the existing downstream drainage system of Bayberry Lane. Conclusions have been drawn based on a hydrological and hydraulic analysis in comparing the pre- and post-development flows for the affected watershed at Analysis Point #1 (A.P. #1) located at a point where the Muddy Brook exits the subject property and at A.P. #2, the existing catch basin near the existing driveway to the Belta property.

The analysis for the watershed was based on TR-55 methodology. The entire drainage area analyzed for the project site for pre-development conditions totals to 19.72 +/- acres to A.P. #1 (located point where the Muddy Brook exits the property) and 4.04 +/- ac to A.P. #2 (existing catch basin in Bayberry Lane that drains towards the Muddy Brook) . The drainage area under the post development conditions is 21.33 +/- acres to A.P. #1. At A.P. #2, the post-development drainage area is approximately 2.5 +/- acres. The rating curves for the control structures, including the bio-swale overflow weir and underdrain are included in the Pond Report section of Appendix "B".

The proposed storm sewer collection system was sized by the Rational Method for the 25-year storm period. An additional analysis utilizing TR-55 flow estimates of both the Private Road storm sewer collection system and the proposed connection to the Bayberry are provided in Appendix 'B'.

Drainage Area 'C' includes approximately 400 feet of the private road with a greater contribution of runoff coming from off-site sources as part of the A.P. #2 watershed. The private road system will enter the Town system via the proposed catch basins located near the entrance to the subdivision. The remainder is overland sheet flow to the existing catch basins located upstream and downstream of the confluence connection point. The Town sewer then discharges to the Muddy Brook as a 15" HDPE cross culvert from the lower catch basin. This discharge is located within the Town ROW as verified by this office.

The Town collection system along Bayberry Lane was analyzed by the Rational Method for a 25-year storm in conjunction with HEC 5, a methodology used for developing rating curve of pipe culverts and Manning's Equation for estimating pipe full flow capacity. This analysis was further compared to the TR-55 25-year storm flow estimates. The drainage area was divided into four sub watersheds with each area's runoff captured by an existing or proposed catch basin. The analysis estimates the maximum safe flow at 9.25 cfs based on HEC-5, while maintaining 1 foot of freeboard inside of the catch basin. Analyzing the flows by the Rational Method for the 25-year storm shows the 15" diameter outfall pipe to have an estimated full flow capacity of 15.0 cfs. The post-development design flow is estimated at 7.09 cfs. By comparison, the TR-55 flow was estimated at 13.33 cfs. The HGL elevation of the post-development flow condition is 156.1'+/-; for TR-55 the HGL is 156.23'. The TR-55 estimated flow to A.P. #2 is 21.3 cfs under existing conditions and

13.7 cfs under the proposed development condition; a 35.7% reduction in flow. Although the proposed development does lower the flow to the Town drainage system on Bayberry Lane, the overall performance of the cross culvert under the 25-year storm event appears to be adequate to provide safe conveyance of storm water to the Muddy Brook, without necessary improvements.

Refer to Figures #2 and #3 for the pre- and post-development watershed delineations and soil mapping based on NRCS soil maps.

Refer to Table #4 for pre- and post-construction peak flow rate comparisons.

Refer to Appendix 'B' – Rational Method Analysis for Stormwater Collection System

The design storm criteria outlined for the evaluation of storm water management facilities is as follows:

DESIGN APPLICATION	DESIGN FREQUENCY
• Storm Drainage Collection System	25 Year
• Minor Cross Culverts	25 Year
• Evaluation Impact for Development Peak Runoff	2, 5, 10, 25, 50 & 100 Year
• Overflow Spillway Design	100 Year
• Detention Basin Outlet Level Spreader	25 Year

Hydrologic and hydraulic estimates were based on the following technical theorems, methods and practices of drainage analysis and design in the assessment of pre- and post-development conditions:

A. *Hydrologic Runoff Estimates*

- Hydraulic Concept: The analyses of the proposed detention ponds and the modeling of the existing ponds and existing hydraulic structures downstream of the proposed site were conducted using the "Hydrology Studios" Program, version 2014. HSP computes SCS Method runoff hydrographs by convoluting a rainfall hyetograph through a unit hydrograph. This method is the same as used in the National Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), TR-55 program. TR-55 is based upon methodologies and acceptable practices and values published in the National Engineering Handbook, Section 4, Hydrology, commonly referred to as NEH 4.
- Storm Frequencies Analyzed: 2, 5, 10, 25, 50 & 100 year, 24-hour Type III storm
- Runoff Coefficients "CN": Weighted average of soil complex number for the various basin hydrologic soil groups from U.S. Department of Agriculture, Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release Number 55, Washington D.C. as amended.

- Time of Concentration: Time of concentration (Tc) values was calculated using the methodologies as described in Technical Release 55 (TR-55), Chapter 3. Input values were obtained from interpretation of the 100 scale topographic map and the USGS quadrangle map and on an assessment of values established by Manning's Kinematic Solution (Overton & Meadows, 1976) and Figure 3-1 (TR-55, Second Edition, June, 1986).
- Rainfall Intensity "I": Precipitation values area based on the recently published NOAA atlas 14, Volume 10 that provides for adjusted rainfall values for New York and the New England States.
- Drainage Areas: Estimated from a digital planimeter utilizing aerial topography.
- Hydrologic Soils Groups: Established from NRCS Soils mapping for Connecticut, prepared by Natural Resources Conservation Service.
- Capacity Analysis of Hydraulic Structures: Location and hydraulic characteristics interpreted from field observations, existing reports, and field survey data; capacities reflect estimates for normal flow and headwater assumptions with of without tail water control, depending on site conditions. Connecticut Department of Transportation "Drainage Manual 2000" and local DPW regulations were used for analysis guidelines. Grate inlets are assumed 50% plugged for the hydraulic effective opening.
- Detention Basin Outlet Level Spreader: Town goal is to minimize potential rill erosion by limiting the flow to 0.2 cfs/10 feet.

B. *Stormwater Collection System*

An analysis of the proposed stormwater collection system was undertaken to determine the required size of each drainage pipe. This analysis was based on the following assumptions and estimates:

- Hydraulic Concept: Conventional Rational Method to establish peak flows for areas under 100 acres. The peak flow is equal to the formula Q=CIA. Manning's equation to determine the minimum slope and pipe diameter required to convey the peak flows.
- Inlet Design: FHWA HEC No. 22 for inlet interception capacity and carry over flows. Grate inlets are assumed 50% plugged for the hydraulic effective opening.
- Culvert Design: FHWA HDS No. 5 for inlet interception capacity and headwater elevation estimation.
- Storm Frequencies Analyzed: 25-year storm event for stormwater collection systems and 25-year storm event for cross-culverts.
- Runoff Coefficients "C": A weighted value was utilized based on published empirical coefficients representing the relationship between rainfall and runoff.

- Time of Concentration: Overland flow time estimates were made based on Seelye and shallow concentrated charts and Manning's equation for time of concentrations in combination with TR-55 worksheets.
- Rainfall Intensity "I": The 5, 15 and 60-minute precipitation values for the 2 and 100-year storm frequencies from the NOAA Atlas 14, Volume 10 were used to generate the I-D-F curves. The data from these curves was then used to obtain rainfall intensity values for various times of concentrations and storm frequencies.
- Drainage Areas: Estimated from a digital planimeter utilizing field or aerial topography, GIS and USGS mapping.

C. *Water Quality Volumes and TSS Removal Rates and Efficiencies Calculations*

An analysis of the proposed stormwater treatment train and post development conditions was undertaken to determine the required volume for water quality and the removal rate efficiencies for the treatment train. The analysis was based on the following assumptions and estimates:

- Water Quality Volume: Connecticut Department of Energy and Environmental Protection "2004 Stormwater Quality Manual."

The basic premise is to design bio-retention water quality basins and infiltration systems for the first flush of rainfall, typically established as a one-inch storm event. It is estimated that 85% of the annual rainfall is less than a one-inch storm.

Reference is made to Appendix B, last tab for the Water Quality Volume calculations for each drainage area considered. The subdivision plans provide water quality volumes and suggested capacity requirements but can vary depending on the actual house to be built. The plans demonstrate the feasibility of an infiltration system for the lot utilizing plastic chambers and stone.

1.6 SUMMARY AND CONCLUSIONS

The peak flows for pre- and post-development for the runoff generated by the site are summarized in Table #4. The conclusion of the analysis shows that the proposed drainage network has a net effect of reducing post-development estimated flows to below those generated by existing site conditions. All storm events are adequately detain on site with the proposed stormwater management systems to A.P. #1 and A.P. #2. For the 2-yr and 100-yr storm events, the runoff is reduced by 2.5% and 6.6%+/-, respectively. At the 100 year storm the discharge rate is reduced from 65.1 cfs to 60.8 cfs. At A.P. #2, the 2-YR storm reduction is 31.5% and the 100-YR storm is reduced by 36.8%, primarily a result of the reduced watershed drainage area. The studies findings conclude no improvements are required off-site to the Town's drainage system or to the existing twin 24-inch culverts serving Muddy Brook.

Refer to Table No. 4 for pre- and post-development flows estimates.

1.7 RECOMMENDATIONS

The following Best Management Practices should be employed to protect wetlands, watercourses and the quality of water affected by the project:

A. During construction, closely follow the Connecticut Department of Energy and Environmental Protection's (CTDEEP) guidelines for Erosion and Sediment Control.

B. Identify a site monitor to regularly inspect the sediment and erosion controls throughout the construction period and provide reports to the Town.

C. Incorporate three-foot sumps in all catch basins with hooded outlets to trap road sands, debris, and oily water.

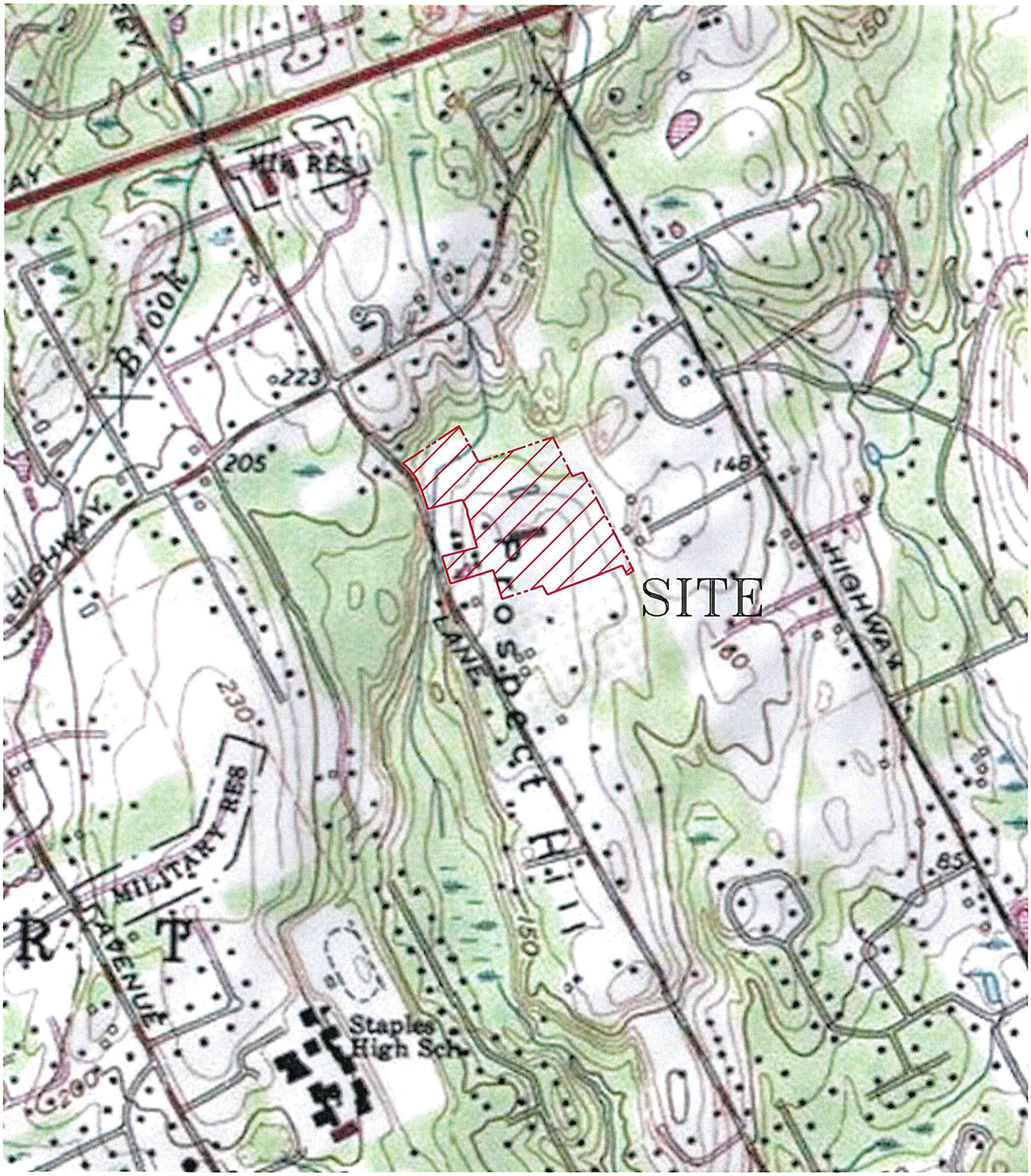
D. Stormwater collected from rainfall and snowmelt will be ultimately distributed to surface water treatment systems utilizing Continuous Deflective System technology.

E. During construction, polymer systems can be introduced to provide water quality retention times appropriate to remove particulate materials and pollutants.

F. Employ an annual maintenance program for the inspection and maintenance of permanent stormwater controls to assure that the systems operate effectively.

DYMAR

APPENDIX A – FIGURES & TABLES



DYMAR

800 Main Street South Southbury, Ct. 06488 (203) 267-1046 · Fax (203) 267-1547
ENGINEERING · PLANNING · SURVEYING · DEVELOPMENT SERVICES

BELTA SUBDIVISION

LOCATION
MAP

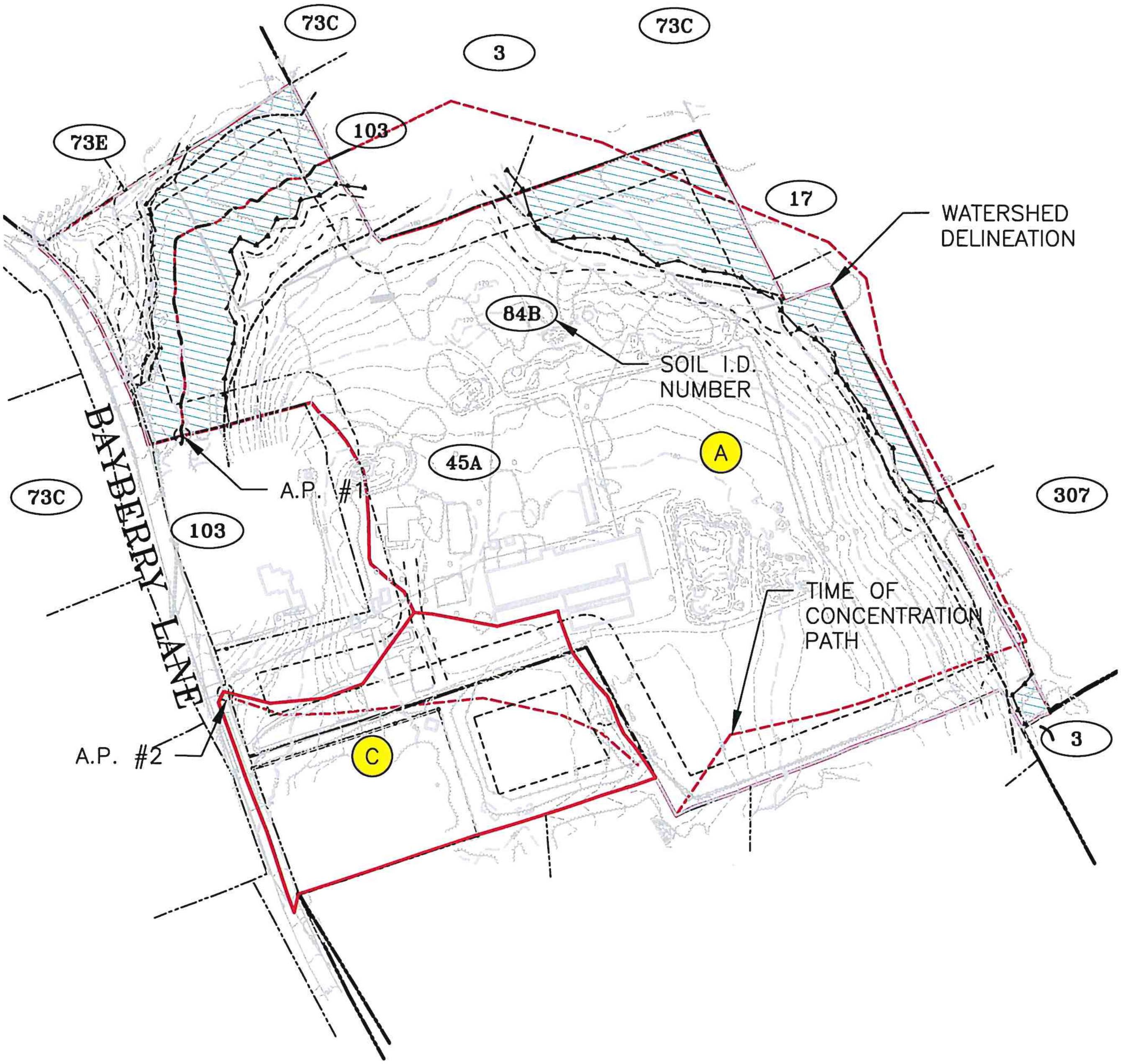
WESTPORT, CONNECTICUT

All measurements are approximate and are subject to final verification by this office.

0" 1" 2"

Job No: 00934
Scale : 1" = 1000'

FIGURE No. 1



#	WATERSHED SUBAREA
——	WATERSHED DELINEATION
-----	TRAVEL PATH

DYMAR

800 Main Street South Southbury, Ct. 06488 (203) 267-1046 · Fax (203) 267-1547
ENGINEERING · PLANNING · SURVEYING · DEVELOPMENT SERVICES

BELTA SUBDIVISION

PRE-DEVELOPMENT
WATERSHED MAP

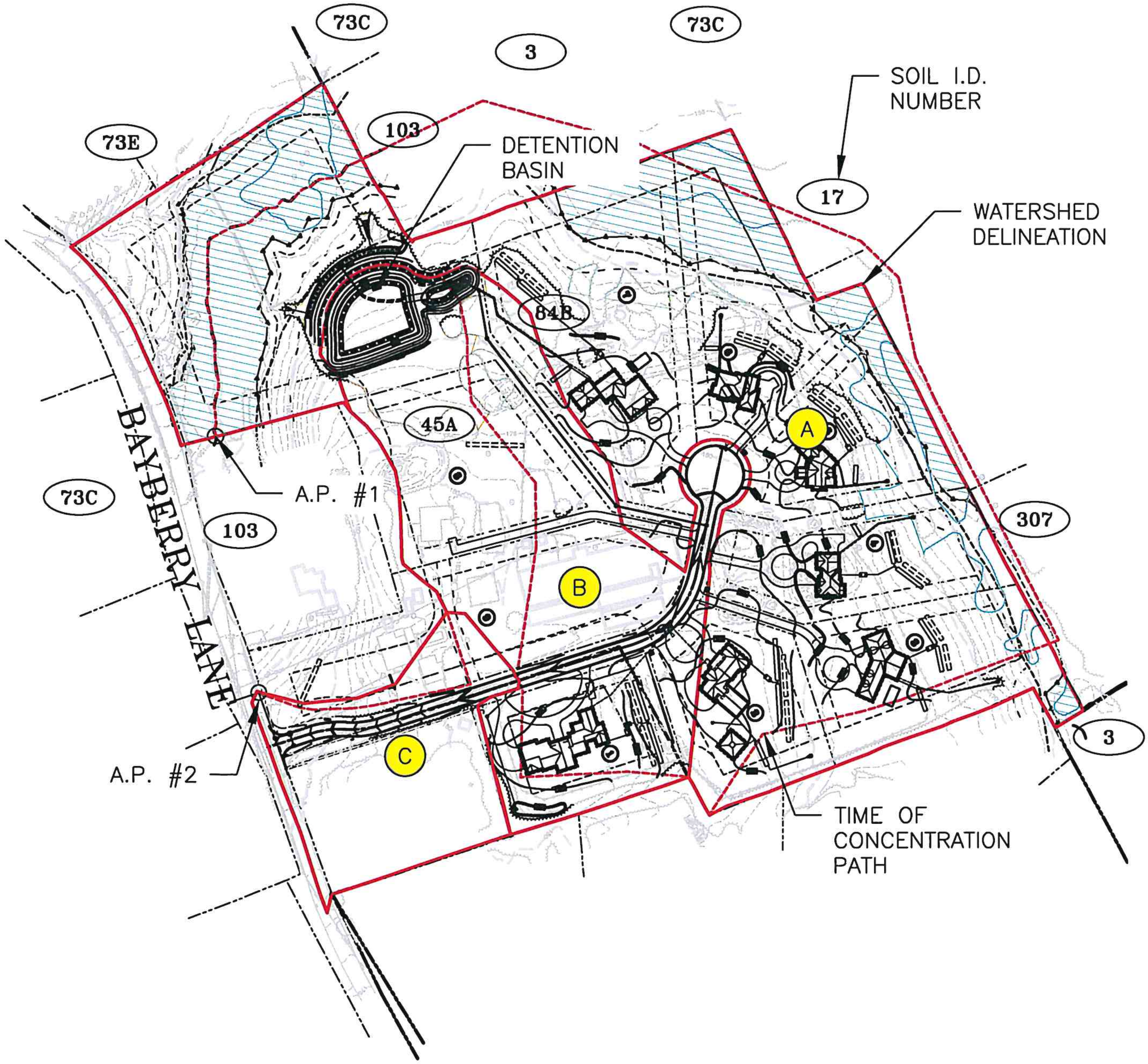
WESTPORT, CONNECTICUT

All measurements are approximate and are subject to final verification by this office.

0" 1" 2"

Job No: 00934
Scale : 1" = 250'

FIGURE No. 2



WATERSHED SUBAREA
WATERSHED DELINEATION
TRAVEL PATH

DYMAR
800 Main Street South Southbury, Ct. 06488 (203) 267-1046 · Fax (203) 267-1547
ENGINEERING · PLANNING · SURVEYING · DEVELOPMENT SERVICES

BELTA SUBDIVISION

POST-DEVELOPMENT WATERSHED MAP

WESTPORT, CONNECTICUT

All measurements are approximate and are subject to final verification by this office.

0" 1" 2"

Job No: 00934
Scale : 1" = 250'

FIGURE No. 3

FIGURE #4

Basin Model

Hydrology Studio v 3.0.0.16

Project Name: Belta Final Rev

08-18-2020

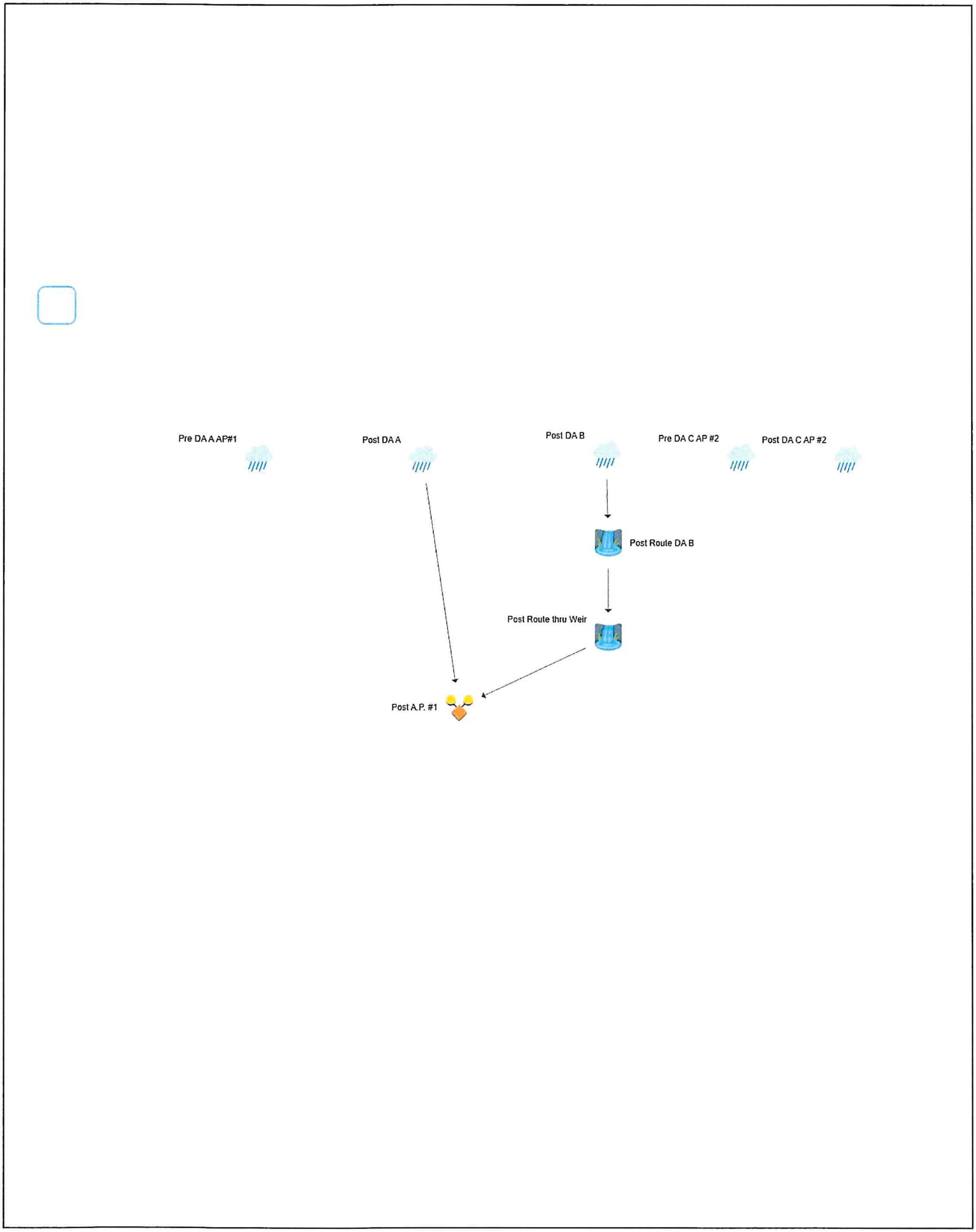


TABLE 1
WATERSHED MODEL CHARACTERISTICS
PRE-DEVELOPMENT ANALYSIS

Drainage Area Pt. No.	Area (Acres)	Weighted CN Value	Time of Concentration (Min.)
A	19.72	76	40
C	4.04	81	5
Total	**23.76**		

TABLE 2
WATERSHED MODEL CHARACTERISTICS
POST-DEVELOPMENT ANALYSIS

Drainage Area Pt. No.	Area (Acres)	Weighted CN Value	Time of Concentration (Min.)
A	14.70	77*	48
B	6.63	83*	25
C	2.44	84	5
Total	**23.76**		

* The CN numbers presented for Drainage Areas 'A' and 'B' in post-development conditions are reflective of fully built-out lots of 25% impervious cover.

TABLE #3

Hydrograph by Return Period

Hydrology Studio v 3.0.0.16

Project Name: Belta Final Rev

08-18-2020

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Outflow (cfs)							
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	NRCS Runoff	Pre DA A AP#1		15.83		25.50	33.96	46.03	55.19	65.07
2	NRCS Runoff	Post DA A		11.42		18.08	23.87	32.07	38.28	44.97
3	NRCS Runoff	Post DA B		8.699		12.90	16.45	21.38	25.05	28.96
4	Pond Route	Post Route DA B		4.118		5.417	6.329	7.697	15.19	16.00
5	Pond Route	Post Route thru Weir		4.118		5.417	6.329	7.695	15.20	16.00
6	Junction	Post A.P. #1		15.42		23.30	29.91	39.07	52.90	60.75
7	NRCS Runoff	Pre DA C AP #2		8.374		12.63	16.24	21.26	25.04	29.08
8	NRCS Runoff	Post DA C AP #2		5.741		8.379	10.59	13.66	15.94	18.38

TABLE 4

COMPARISON OF PRE- AND POST-DEVELOPMENT DRAINAGE ESTIMATES

Pt. No. Design Storm	A.P. #1 Pre- (cfs)	Post- (cfs)	Diff. (%)	Basin WSE (Ft.)
2-YR	15.8	15.4	-2.5	159.29
5-YR	25.5	23.3	-8.6	160.56
10-YR	34.0	29.9	-11.9	161.64
25-YR	46.0	39.1	-15.1	163.02
50-YR	55.2	52.9	-4.1	16.40
100-YR	65.1	60.8	-6.6	164.03

Pt. No. Design Storm	A.P. #2 Pre- (cfs)	Post- (cfs)	Diff. (%)
2-YR	8.4	5.7	-31.5
5-YR	12.6	8.4	-33.7
10-YR	16.2	10.6	-34.8
25-YR	21.3	13.7	-35.7
50-YR	25.0	15.9	-36.3
100-YR	29.1	18.4	-36.8

800 Main Street South • Southbury, Ct 06488 • (203) 267-1046 • Fax (203) 267 1547
ENGINEERING • PLANNING • SURVEYING • DEVELOPMENT SERVICES

Project:	Belta Subdivision Westport, CT
Job No. :	00934
Date :	3/31/2020
Designed By :	S.A.L.
Rev:	8/17/2020

Table 5 - Detention Basin Weir Rating Curve

Maximum flow rate per Westpost PDW is 0.2 cfs per 10 LF

Weir flow estimated for a Cipolletti Weir model.
Flow = 3.367*L*H^1.5

Weir Length = 190 ft
Max Flow = 3.8 cfs

General Rating Curve:

Stage (ft)	Area (sft)	Flow (cfs)	Flow (cfs/10 lf)	Vel (fps)
0.00	0.00	0.00	0.000	0.00
0.05	9.50	7.15	0.376	0.75
0.10	19.00	20.23	1.065	1.06
0.15	28.50	37.16	1.956	1.30
0.20	38.00	57.22	3.012	1.51
0.25	47.50	79.97	4.209	1.68
0.30	57.00	105.12	5.533	1.84
0.35	66.50	132.46	6.972	1.99
0.40	76.00	161.84	8.518	2.13
0.45	85.50	193.11	10.164	2.26
0.50	95.00	226.18	11.904	2.38

Exact Solutions:

Stage (ft)	Area (sft)	Flow (cfs)	Flow (cfs/10 lf)	Vel (fps)	
0.035	6.575	4.12	0.217	0.626	2yr
0.042	7.893	5.42	0.285	0.686	5yr
0.046	8.756	6.33	0.333	0.723	10yr
0.052	9.975	7.70	0.405	0.771	25yr
0.083	15.703	15.20	0.800	0.968	50yr
0.086	16.249	16.00	0.842	0.985	100yr

Stage heights are to be added to final weir design elevation of 158.00'.
Refer to Appendix 'B' for Pond Report for discharge calculations of Weir under drain outets.